THE ROLE OF ORTHOGRAPHIC CUES TO LEXICAL STRESS IN WORD RECOGNITION: A COMPARISON OF MONOLINGUALS AND BILINGUALS

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ABSTRACT

The Role of Orthographic Cues to Lexical Stress in

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The present research tested the claim that users are guided by orthographic correlates of lexical stress even in languages without diacritic markers of stress. Given that disyllabic English nouns typically have a trochaic stress pattern (strong-weak) whereas verbs tend to have an iambic pattern (weak-strong), as in REject and reJECT, respectively, the study examined whether word endings reliably signal stress and syntactic category information in English. The study also examined if sensitivity to orthographic cues to stress and syntactic category differs as a function of language experience (monolingual vs. bilingual). Twenty two monolinguals and 18 bilinguals were given a list of disyllabic English pseudowords containing 16 noun-like endings, 16 verb-like endings, and 16 neutral control endings. Corroborating a previous finding with monolinguals (Kemp, Nilsson, & Arciuli, 2009), the results showed that pseudowords containing noun-like endings were reliably perceived to be nouns whereas those with verb-like endings were reliably

classified as verbs. This overall pattern also characterized bilinguals' performance, although monolinguals were found to be significantly more sensitive than bilinguals to noun-like endings. In addition, monolinguals displayed higher overall confidence than bilinguals in their word class judgments. With respect to stress assignment, monolinguals were more likely to assign stress to the first syllable for words with noun-like or control endings, and to assign stress to the second syllable for words with verb-like endings. They also showed significantly greater first syllable stress assignment than bilinguals for pseudowords with noun-like endings. Bilinguals' stress assignment pattern did not vary by word ending type. Taken together, the findings indicate that whereas orthographic cues are used by monolinguals and bilinguals alike to signal word class, these cues are not relied on to the same extent by the two groups for determining lexical stress. Bilinguals' knowledge of stress patterns in another language may have contributed to their lack of sensitivity to orthographic cues of word class in making stress assignment decisions for English pseudowords. Implications of these findings and directions for further inquiry are suggested.

ACKNOWLEDGMENTS

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CHAPTER I

INTRODUCTION

Lexical stress refers to the relative prominence of a syllable within a word. This study sought to explore the role of orthographic cues to lexical stress assignment by monolinguals and bilingual adults, and the relationship between use of stress assignment cues and orthographic cues signaling word class. Previous research on the functional significance of lexical stress in word recognition has been limited owing to a focus of most studies of word recognition on monosyllabic words. An exception is the pioneering work of Anne Cutler, who has been responsible for much research on the processing of prosodic information in segmenting the phonetic stream of speech into its grammatical constituents.

In *Native Listening: Language experience and the recognition of spoken words* (2012), Cutler provides a survey of psycholinguistic research on this topic. In particular, she discusses the 'rhythmic segmentation hypothesis.' This hypothesis posits a strong connection between stress and the phonological patterns of a language. It claims that speakers are more likely to assign stress based on phonologically regular units. Cutler and Norris (1988) showed that it is much easier for listeners to extract lexical information from stressed content than from non-stressed. In their study participants were presented with pseudowords such as *'mintayf'* and *'mintef'* and were asked them to extract the English word *'mint'*. It was significantly easier for participants to do this with *'mintayf'* because this word follows a strong-strong stress pattern, whereas *'mintef'* is read as strong-weak. It can be concluded that *'mintef'* was analyzed as a lexical unit, whereas *'mintayf'* was perceived as two distinct units. These results were also found to hold crosslinguistically. For example, speakers of Japanese, which has a syllable structure that is very

different from that of English, find the word *'tan'* much more easily in the pseudoword *'tanshi'* than in *'tanishi'* (Cutler, 2012). This is because in *'tanshi', 'tan'* constitutes its own stressed syllable, whereas in *'tanishi'* it is part of the styllable *'tani'*.

Other studies have also underscored the role of stress in word recognition. Ramus and Mehler (1999) showed that stress provides a strong cue to the language of an utterance. Using speech resynthesis techniques, they demonstrated that adult French speakers can successfully distinguish English from Japanese based solely on syllable stress patterns. Furthermore, Braun, Dainora, and Ernestus (2011) demonstrated that unusual intonation patterns slow down online comprehension. Their study used Dutch participants. Dutch uses intonation to indicate pragmatic information, such as the attitude of a speaker in an utterance, but it does not use it to indicate lexical information. As such, it might be thought that changing the intonation pattern would not affect online comprehension. However, their results showed that speakers rely heavily on intonation patterns in order to correctly segment a speech stream, despite the fact that intonation is not used at the lexical level.

A number of studies have explored how readers use orthography to access stress patterns. Gutierrez-Palma and Palma-Reyes (2007) tested speakers of Spanish, examining if speakers processed words that contained correct diacritic stress markings more easily than words containing incorrectly marked words. For example, they asked if lexical decision to a word preceded by an incorrectly stressed prime (cájon') slows processing relative to when the wrod is preceded by the correctly stressed prime (*'cajón')*. The researchers found that lexical stress does have an effect on lexical processing, and that its effect appears relatively late in processing (143 ms stimulus onset asynchrony). Additionally, research with Greek participants examined the role of diacritics in lexical processing. Greek has a very transparent orthography with regard to

decoding stress. Protopapas and Gerakaki (2009) showed that diacritic marks do not play a critical role in reading development, but that the role of diacritics, especially when decoding unfamiliar words, increases in importance with age. Specifically, they showed that 7th grade children were much more likely to decode a word based on its diacritic markings than were 2nd-4th grade children. These results provide crosslinguistic evidence that orthography affects how participants identify the stress pattern of a word.

Determining the correct stress pattern of a word while reading can be a very challenging task, especially in languages like English that do not a fixed stress pattern, lack transparent or consistent phoneme to grapheme correspondence and also lack diacritic markers of stress. Nevertheless, some research has demonstrated that readers may use other orthographic cues in the absence of diacritics to help users determine the correct stress of a word in these types of languages. Cues that have been examined in previous studies include syllable structure, such as number and doubling of letters in different positions in the word (Kelly, 2004), word length (Cassidy & Kelly, 1991), type of morphological ending, and type of non-morphological word ending, e.g., *-erge* (Kemp, Nilsson, & Arciuli, 2009).

Some research with English speakers has sought to link users' reliance on cues for stress assignment to orthographic cues for syntactic category of words (nouns vs. verbs). There are two major types of lexical stress of English. The first is 'trochaic' stress, which is a strong-weak pattern, as in the word '*college*'. The trochaic pattern turns out to be most prevalent among nouns. In fact, approximately 90% of disyllabic nouns exhibit the trochaic pattern (Kelly & Bock, 1988). The other pattern is 'iambic', which is a weak-strong pattern, as in the word '*convey'*. This pattern occurs in about 70% of disyllabic verbs (Kelly & Bock, 1988).

Kelly (2004) showed that readers were more likely to place trochaic stress on pseudowords that had a large number of consonants in the initial position. For example, ‘plonveen’ was more likely to be pronounced with stress on the first syllable than was ‘ponveen’, because the onset ‘plon’ contains more consonants than ‘pon’. In other words, relatively ‘heavy’ syllables are more likely to be stressed than ‘lighter’ ones. Cassidy and Kelly (1991) demonstrated that English speakers are sensitive to the fact that English nouns have a higher mean syllable number than do verbs. In other words, a long word (e.g. trisyllabic) is more likely to be a noun than a verb. The fact that speakers are sensitive to this statistic suggests that they may use it to determine lexical stress.

Kemp et al. (2009) noted that previous studies of orthographic correlates of stress tended to have relatively small sets of stimuli and that the pseudoword stimuli used were often quite similar to actual words and thus stress assignment could be based simply on analogy (e.g. *hatchel/satchel*). Kemp et al. developed a more extensive set of disyllabic pseudoword stimuli containing noun-like and verb-like endings. In addition, they had a control set of stimuli which did not cue noun or verb status. Kemp et al. presented the stimuli to English speaking monolinguals in a variety of tasks. One of these is of particular relevance to the present study: a syntactic category classification task. In this task participants were to decide if a given pseudoword was a noun or a verb. Kemp et al. found that words with certain endings, e.g., *‘-oon’,* tended to be classified as nouns whereas those with other endings, e.g. *‘-erge’,* tended to be classified as verbs. In other words, Kemp et al. showed that speakers are likely to classify a pseudoword as a noun if it has a noun-like ending, and to a lesser extent, they are more likely to classify a pseudoword as a verb if it has a verb-like ending. Their results supported this prediction. However, Kemp et al. (2009)

did not include a stress assignment task.

To sum up, previous studies have uncovered a variety of subtle orthographic cues that users appear to rely on in making stress assignment decisions for written words. Although some previous studies have examined stress assignment in non-native speakers of a language, there is a need for more research on the role of language experience in stress judgments. The present research sought to redress this gap. The study compared the performance of English-speaking monolinguals and highly proficient non-native speakers of English as a way of exploring whether sensitivity to orthographic cues to stress and to word class is linked to language experience. Although we did not test bilinguals on Spanish, our study was informed by prior research on the processing of lexical stress in Spanish (e.g., Gutierrez-Palma & Palma-Reyes, 2007) which led us to a hypothesis about bilinguals' performance in English. That is, given that Spanish provides clear orthographic cues for stress (accent marks) we might expect that in the absence of such overt cues in English Spanish speakers may not be as sensitive as native English speakers to the influence of the subtle cues to stress placement (or to noun/verb classification) that are present in English. The present experiment thus examined the relative contribution of language experience (English monolinguals vs. English/Spanish bilinguals) and word ending type (noun-like vs. verb-like vs. control endings) on the assignment of appropriate stress to English disyllabic pseudowords, and the relationship between stress assignment and word class judgment.

Arciuli and Cupples (2006) showed that readers are sensitive to word ending in determining the stress of a word. Their study presented English readers with pseudowords that had either a verb-like or noun-like ending. For noun-like endings, readers were more likely to elicit a trochaic pronunciation, whereas the verb-like endings produced an iambic pronunciation. In the present

study, we propose to present participants with similar stimuli, but this time with an improved list of stimuli from Kemp et al. (2009). The former list presented serious flaws with regard to pseudoword status, particularly in an area like analogical extension. For example, one pseudoword from their list is *hatchel*, which can be easily extended by participants to *satchel*, and therefore all stress patterns and word classification would be influenced by the actual English word. In all, only 3 of the 40 words from this list differed by more than one letter from an actual English word (Kemp et. al, 2009). The latter list is an improvement because the authors ensured that there were no close analogical extensions in the list of pseudowords. Additionally, they provide a list of control words, which have endings that are not strongly correlated with nouns or verbs. This study is significant because it is the first to make use of Kemp et al.'s (2009) superior list to examine how stress assignment and word classification are related.

Another important extension of this study is the comparison between monolingual and bilingual speakers. To date, no study has been done using the stimuli from either Arciuli and Cupples (2006) or Kemp et al. (2009) that takes into account bilingual effects. Such a study is important because bilingual effects allow us to examine how 'deep' in the grammar a certain phenomenon is. In other words, are the observed effects of word classification and stress assignment merely byproducts of English that are not necessary for full acquisition, or are they more deeply engrained in the grammar? If the relationship is more *ad hoc*, we expect that bilinguals will not be as sensitive to cues for word classification or stress as monolinguals.

There are several predictions based on other studies that we can make about how bilingual speakers will react to the stress judgment part of this study. Ramus and Mehler (1999) have shown that infants are able to discriminate between two languages solely on stress pattern. They accomplished this using a low pass filter technique, which took out phonetic information from

the speech stream but left prosodic content. Their study is important because it demonstrates the early primacy of prosodic information in language acquisition. However, Ramus and Mehler did not provide any information on how stress may inform word class. Guion, Harada, and Clark (2004) found that late bilinguals (age of acquisition > 12) were less sensitive to differences in syllable structure between word classes. Since syllable structure is directly related to lexical stress (Kelly, 2004), these results suggest that the bilinguals in our study might not use prosodic information to inform word classification. Additionally, Guion et al. (2004) noted that prosodic differences between word class such as noun and verb are not as prominent in Spanish. Rather, a more general rule of penultimate stress is followed, instead of a set of rules contingent on word class. Additionally, Gutiérrez-Palma and Palma-Reyes (2007) remarked that in the absence of diacritic marking, which is prevalent in Spanish, Spanish-English bilinguals may not be as sensitive to prosodic information in orthography. This speculation is significant because the majority of our bilingual participants in the present study (16 out of18)were Spanish-English bilinguals. It is possible, then, that we may find differences across our bilinguals and monolinguals in sensitivity to stress.

We can also make informed predictions about how bilinguals will perform in the word classification task. Many studies have demonstrated that bilinguals perform the same as monolinguals on tasks involving the auditory perception or oral production of stimuli involving the prosodic and phonetic differences. For example, Davis and Kelly (1997) showed that bilinguals are just as likely as monolinguals to exhibit the standard stress pattern in English in both the noun and verb word classes. Guion et. al (2004) found a similar effect on the judgment between lexical class and stress pattern. However, it is not known if bilinguals extend this knowledge to stress judgments for words presented in a written mode. . Given that the present

study presented bilinguals with well documented non-morphological suffixes to predict word class, we hypothesized that bilinguals would be sensitive to these patterns. As such, we should expect to observe differences for bilinguals and bilinguals alike with regard to reliance on word ending cues signaling word class. We expect this to be the case even if bilinguals do not make systematic use of this knowledge to guide their judgments of stress.

The present study has important implications for the syntax-phonology interface. While it has been established (Kemp et al., 2009; Cassidy & Kelly, 2001) that speakers use stress to determine word class, there is still a lot to be understood about how stress connects to phonetic content (e.g. the surface string of sounds) when determining word class. Most importantly, it has yet to be demonstrated whether stress or phonetic cues are more informative for word class. Informative stress would entail that stress patterns, such as iambic and trochaic, provide more information than phonetic content, such as type of word ending. This study aims to provide further insight into this area by examining possible bilingual/monolingual differences in word classification and stress assignment.

CHAPTER II

METHODS

The design of the experiment was 2x3 mixed ANOVA, measuring language background (monolingual or bilingual) and category (noun-like, verb-like, and control). The experiment ran this design on two measures: word classification and stress assignment. There were 18 bilinguals and 22 monolinguals. Order was counterbalanced within each group, meaning that half of the participants were presented with Condition A, in which the word classification task preceded the stress assignment task, and half of the participants were in Condition B, in which stress assignment preceded word classification. The list of 48 words was presented in a fixed random order for all participants. Results were entered into a spreadsheet and analyzed using the SPSS statistical software by IBM.

Participants. Twenty-two undergraduate students from a "Psychology of Language" course. We informed these participants that we were simply interested in their perception of 'potential product words for market research'. Post-test interviews concluded that students were not aware of what we were testing. For the bilingual students, we recruited 18 participants from the undergraduate psychology pool. Sixteen of the eighteen bilinguals were Spanish-English speakers. The mean self-rated proficiency score of bilinguals on English was 6.85 out of a maximum of 7 and their self-rated score on Spanish was 6.08 out of 7. Breaking these numbers down, the bilingual scores for English speaking were 6.8, reading was 6.8, writing was 6.73, and understanding was 6.87. For Spanish, speaking was 6.27, reading was 5.8, writing was 5.27, and understanding was 6.53.

Materials. Stimuli were taken from the list used in the pseudoword classification experiment by

Kemp et al. (2009). They included 16 words with noun-like endings, 16 with verb-like endings, and 16 with control endings. Following Kemp et al. (2009), "word ending" was defined as the body/rime of the final syllable of the word or pseudoword. The same set of stimuli, presented in a fixed random order, was presented for each of the two tasks: noun/verb classification and stress assignment. Stimuli were presented on a two-page response sheet (see Appendices). Stimuli in Condition A were presented on white paper, and Condition B was on yellow paper.

Procedure. Our procedure was adapted from that of Kemp et al. (2009) with certain modifications. Participants were tested in small groups and provided with a brief verbal introduction. They then read through the instructions and asked the experimenter if they had any questions. As already noted, the order of presentation of the stress judgment task and the word classification task was counterbalanced, so some participants were administered the stress judgment first and others were given the word classification task first. All participants completed the language background questionnaire at the end of the second task. Most participants took about 20 minutes to complete the experiment.

CHAPTER III

RESULTS

The mean number of responses classified as "nouns" were entered into the analysis of the data for the noun/verb classification task as a function of ending type. In addition, participants' confidence ratings for their noun/verb classification were analyzed. Given that the maximum score on the noun/verb classification task was 16 per ending type, the mean number of "verb" responses can be inferred by subtracting the mean number of "noun" responses from 16. For the stress judgment task the mean number of responses for first syllable stress were analyzed by ending type. In each case, a 3(Ending Type) x 2 (Group: Monolingual vs. Bilingual) mixed analysis of variance was conducted. Two analyses of variance were conducted per task, one analyzing the data by subjects and the other by items. For the by item analysis the proportion of NL, VL and Control items classified as "noun" in the word classification task (or as "first syllable" in the stress task) were computed separately for monolingual and bilingual participants.

A preliminary analysis of variance examined if there was an effect of task order (i.e., doing the noun/verb classification task before or after the stress assignment task) on performance on the stress assignment task. However, no effect of ask order was found. Hence, all subsequent analyses collapsed across this variable.

Noun-Verb Classification Task. Analysis of "noun" choices on the noun/verb classification task yielded a significant main effect of ending type in the by subject analysis, F_1 (2, 76) =36.03, p <.001, and the by item analysis, F_2 (2, 45) =18.65, p <.001. In addition, there was a non-significant effect of group ($F_1(1,38)=2.53$, p=.12, $F_2(1,45)=.96$, p=.33), and a significant

interaction of group by ending type across both analyses, $F_1(2,76)=6.20$, $p<.01$, $F_2(2,45)=7.41$.The effect of ending type in the by subject analysis showed that participants were more likely to classify items with NL (noun-like) endings as nouns than items with VL (verb-like) endings as nouns: t (39) = 7.87, $p < .01$. Moreover, pseudowords with NL endings were more likely to be classified as nouns compared to those with control endings: t (39) = 4.04, $p < .01$. Finally, pseudowords with VL endings were significantly less likely to be classified as nouns compared to items with control endings, t (39) = -4.62, $p < .01$. The effect of ending type in the by item analysis showed that NL items were classified more likely than VL items as nouns ($p < .001$). Moreover, VL items were classified less likely than control items as nouns. However, NL items did not differ from control items in terms of noun classification.

The effect of ending type showed that participants were more likely to classify items with NL endings as nouns than items with VL endings as nouns, t (39) = 7.87, $p < .01$. Moreover, pseudowords with NL endings were more likely to be classified as nouns compared to those with control endings: t (39) = 4.04, $p < .01$. Finally, pseudowords with VL endings were significantly less likely to be classified as nouns compared to items with control endings, t (39) = -4.62, $p < .01$.

The interaction of ending type by group was analyzed further by comparing the effect of ending type within each group. The results of the by subject analysis showed that for monolinguals, a significant difference was found in all three ending type comparisons (NL vs. VL, NL vs. C, VL vs. C). However, bilinguals showed a significant difference only between NL vs. VL and VL vs. C. Additional comparisons were conducted across groups within each ending type. This analysis showed that for items with NL endings monolinguals were more likely than bilinguals to judge the items as nouns, t (38) = 3.38, $p < .01$. However, the two groups did not differ significantly in

the degree to which they judged pseudowords with VL endings as verbs or in how they assigned word class to pseudowords with control endings. Figure 1 summarizes the results on this task by group and word ending type.

For the post hoc analyses of the by item analysis of ending type by group interaction the ending types were compared to each other separately for monolingual and bilingual participants. Both monolingual (t (30) = 5.62, $p < .001$) and bilingual (t (30) = 3.27, $p < .01$) participants classified NL endings as nouns more than VL endings. When comparing NL endings to control endings, only monolingual participants showed a difference (t (30) = 4.18, $p < .001$). For the VL and control endings comparison, both monolinguals (t (30) = 2.36, $p < .05$) and bilinguals (t (30) = 3.72, $p < .001$) reported less noun classification for VL endings than control endings. Further, when monolingual and bilingual participants were compared within the same ending type the only group difference that was found occurred for the NL ending type: items with NL endings were classified as noun more often by monolinguals than by bilinguals, (t (15) = 3.59, $p < .01$).

In summary, the performance of participants on noun/verb class classification of pseudowords varying in word ending type shows a clear sensitivity on the part of monolinguals to orthographic cues to word class, for nouns and verbs alike. Bilinguals also showed sensitivity to word ending cues in discriminating nouns vs. verbs, and verbs vs. items with control endings, but did not differentiate between items with noun-like endings and items with control endings. Moreover, where the two groups differed, it was in the direction of a greater sensitivity by monolinguals to noun-like endings.

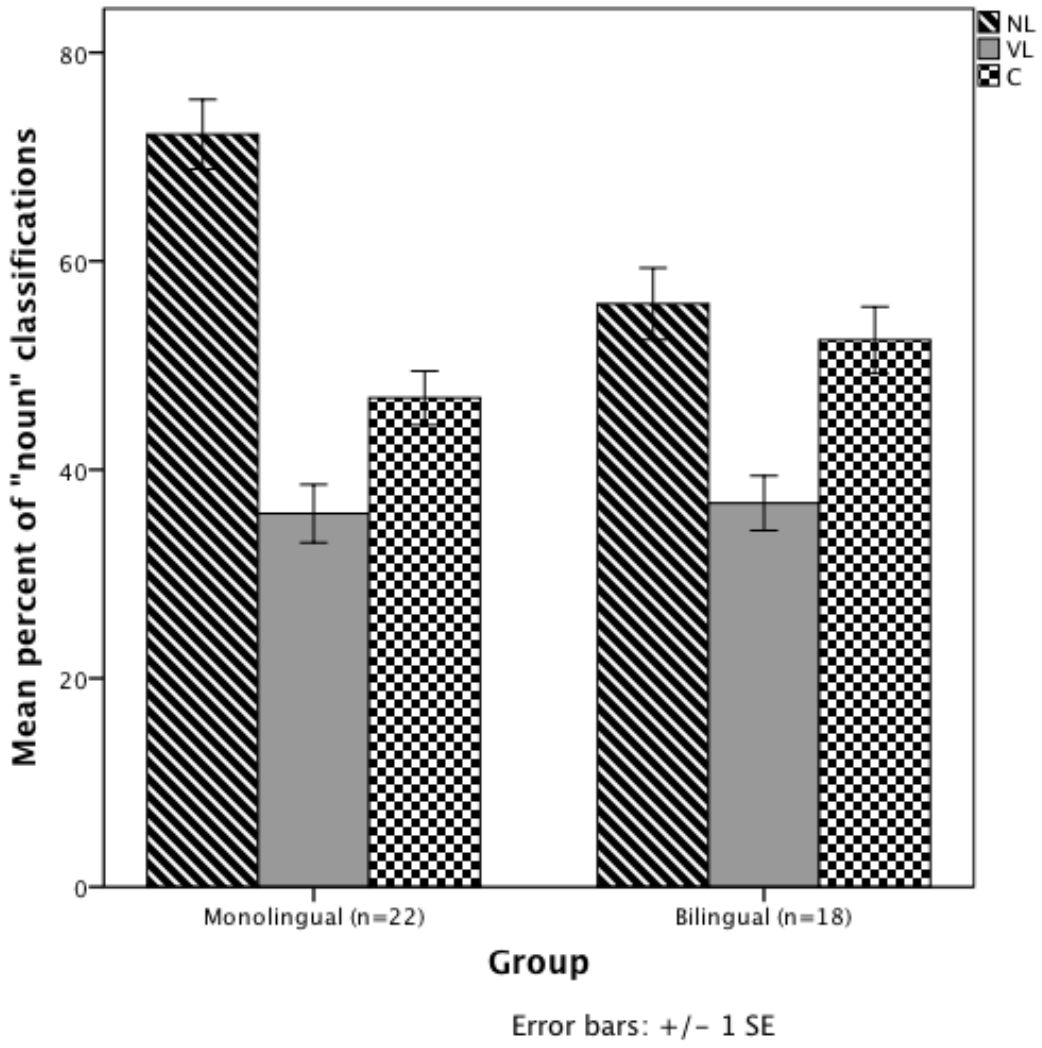

Figure 1: Mean percent of “noun” classifications as a function of word ending type (noun-like, verb-like, and control) and language experience (monolingual vs. bilingual)

Noun-Verb Classification Confidence Ratings. Participants provided confidence ratings for their noun/verb classification on a scale of 1 (not at all confident) to 7 (very confident).An analysis of variance performed on the participants’ confidence ratings yielded a main effect of word ending

type, $F(2,37)=8.844$, $p < .0001$, a main effect of group ($F(1,37)=5.046$, $p<.03$, and an interaction of these two variables, $F(2,74)=6.128$, $p < .003$. The group main effect indicated that monolinguals showed higher overall confidence ratings than bilinguals (4.41 vs. 3.65, respectively). The word ending main effect showed that confidence ratings for items with noun-like endings were higher than those for items with control endings; similarly ratings for items with verb like endings were higher than those for items with control endings. There was no difference in confidence ratings for noun-like vs. verb-like items.

These results were qualified by the presence of a group by ending type interaction, which showed that differential confidence ratings by ending type were largely attributable to monolinguals. That is, monolinguals showed significantly higher confidence ratings for items with NL endings (4.67) than for those with control endings, 4.07, $t(21)=4.517$, $p < .0001$; they also showed higher confidence ratings for items with VL endings (4.48) relative to those with control endings, 4.07, $t(21) =4.326$, $p<.0001$. In addition, monolinguals showed a trend for higher confidence ratings for items with NL endings than for those with VL endings, $t (21) = 1.99$, $p < .06$.

By contrast, bilinguals showed no significant difference in confidence ratings for items with NL endings (3.61) than for those with control endings, 3.59, $t(16)=.26$, $p=.8$, nor did they show a difference in confidence ratings for items with VL endings (3.74) vs. those with control endings, 3.59, $t(16) =1.19$, $p=.25$, or for the comparison of items with NL vs. VL endings, $t(16) =-.97$, $p=.35$.Comparing across groups at each level of ending type, post hoc analyses showed that monolinguals showed significantly higher confidence ratings than bilinguals for items with NL endings, $t(37)=3.044$, $p<.04$, and for items with VL endings, $t(37)=2.113$, $p<.04$, but the two

groups did not differ in their mean confidence ratings for items with control endings, $t(37)=1.357$, $p=.18$.

Taken together, the confidence rating data supplement the findings from the noun/verb classification task in showing that monolinguals were significantly more confident than bilinguals in their classifications of items with endings that clearly signaled word class (nouns or verbs), and their confidence for these items was significantly higher than that for items that did not signal word class (control ending items). Thus, monolinguals' accuracy in classifying nouns and verbs was accompanied by a corresponding high confidence in their judgments; by contrast, bilinguals – despite performing at the same level as monolinguals in classification of verbs, did not show high levels of confidence in their classification judgments for verbs, or for items with the other two ending types. See Figure 2 for a summary of the confidence rating results by group and ending type.

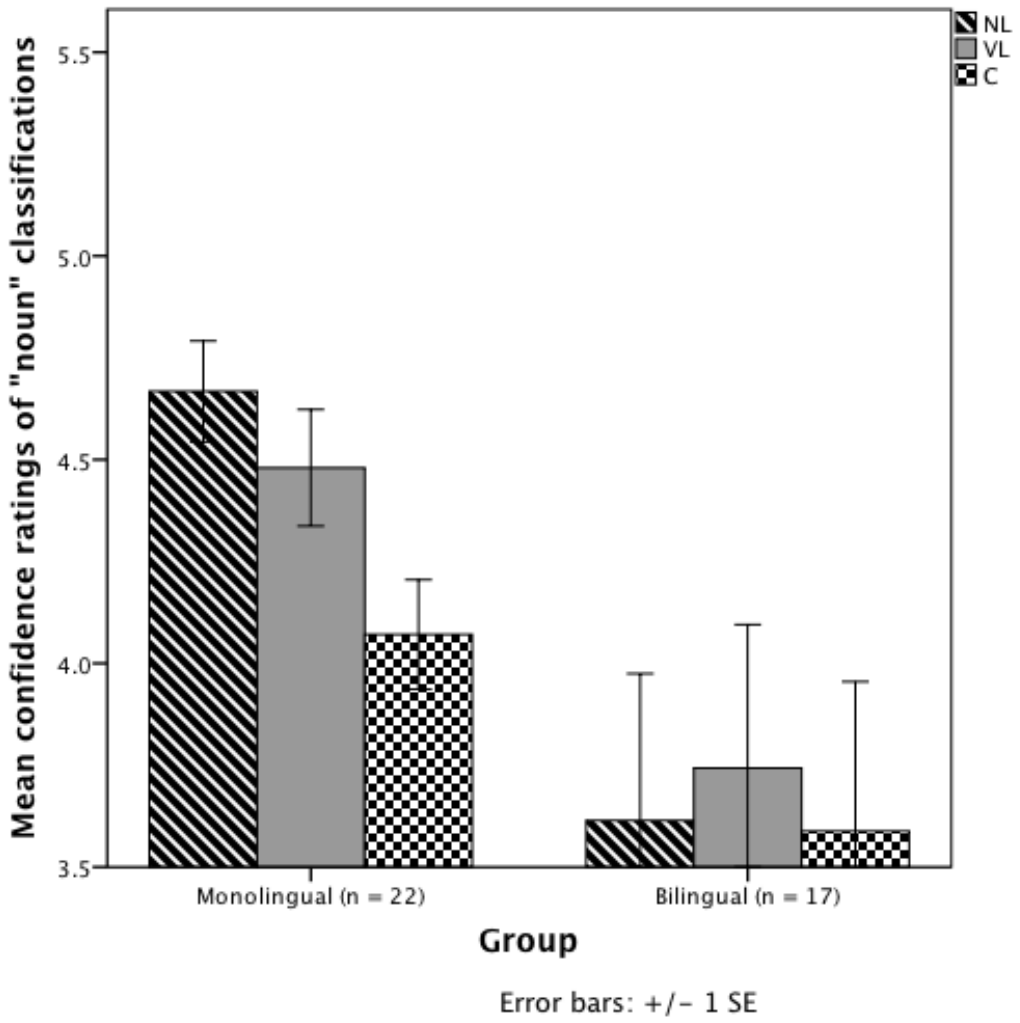

Figure 2: Mean confidence ratings of "noun" classifications as a function of group and word ending type

Stress Assignment Task. A 3 x 2 mixed ANOVA (Word Ending Type x Group) was performed on the stress verification data. The results showed a significant main effect of ending type by subject but not by item, F_1 (2, 76) =5.78, p<.01; F_2 (2, 45) = 2.45, p = .1.

This effect showed that NL words were more likely than items with VL endings to be assigned stress on the first syllable, t (39) = 3.33, p < .01. However, NL endings did not show higher first syllable stress assignment than items with control endings, t (39) = 1.32, p = .19. Finally, VL endings showed lower first syllable stress assignment than items with control endings, t (39) = -2.24, p < .05.

The group effect was not significant by subjects, F_1 (1, 38) = 1.82, p = .18, but was significant by items, F_2 (1, 45) = 9.16, p < .01), indicating that monolingual participants made more first syllable stress assignments than bilingual participants. A significant group by ending type interaction was found by subjects, F_1 (2, 76) = 5.16, p < .01 and by items, F_2 (2, 45) = 4.3, p = .02. Breakdown of the interaction in the by subject analysis revealed the following when comparing across ending type within monolinguals and bilinguals: the effect of ending type was due largely to monolinguals, who showed a significant difference between NL and VL, and between VL and C; they did not differ on the NL vs. C comparison (suggesting they assigned noun-like first syllable stress to items with control endings. For bilinguals, no significant difference was found across any of the three comparisons of ending types. Comparing monolinguals with bilinguals within ending type, the analysis showed that for items with NL endings, monolinguals were more likely to assign first syllable stress than were bilinguals t (38) = 2.43, p < .05. For items with VL or C endings the groups did not differ significantly in their stress assignment response.

Breakdown of the group by ending type in the by item analysis revealed that only monolinguals (t (30) = 3.92, p < .001) showed a significant difference between NL and VL endings in first syllable stress assignment frequency. When comparing NL endings to control endings, neither group showed a significant difference between NL and control ending items. For the comparison between VL and control endings, only monolinguals (t (30) = 2.4, p = .023) reported less first syllable stress assignment for VL endings than control endings. Finally, when comparing monolingual and bilingual participants within the same ending type the only difference found was in the NL ending type: items with NL endings were assigned first syllable stress more often by monolinguals than bilinguals (t (15) = 4.22, p < .001).

Thus, in making stress assignment decisions, monolinguals were influenced by word endings, choosing trochaic stress for items with noun-like endings and control endings and iambic stress for items with verb-like endings. Bilinguals were not sensitive to word endings in assigning stress. Rather they tended to assign stress similarly across the three item types. Both bilinguals and monolinguals responded similarly when assigning stress to words with verb endings and control endings. Monolinguals were significantly more likely than bilinguals to give a trochaic stress to noun endings. See Figure 3.

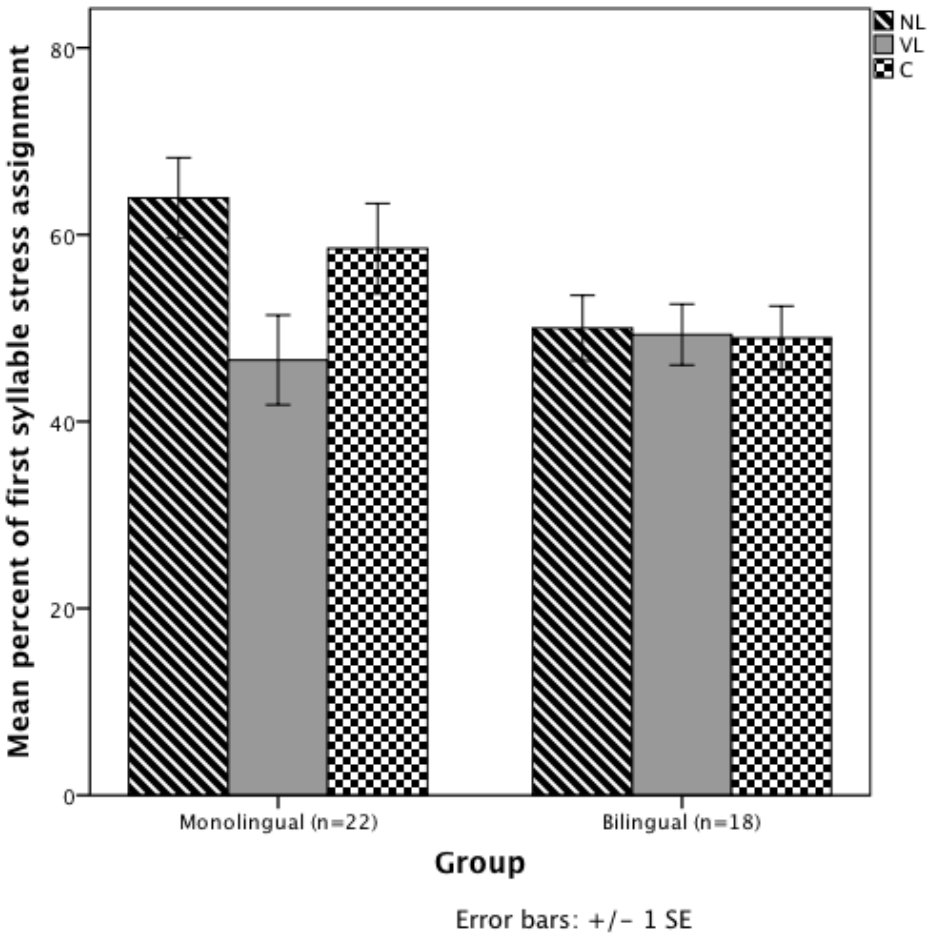

Figure 3: Mean percent of first syllable stress assignment by word ending type and group

Relationship between Noun/Verb Classification and Stress Assignment. The last measure we examined was the correlation between noun choice and stress judgment on the first syllable. This was done to determine if there was a relationship between choosing first syllable stress and choosing a noun. Results from a Pearson product moment correlation computed on the item analysis for this comparison are displayed in Figures 4 and 5 for monolinguals and bilinguals, respectively. The x-axis shows the number of first syllable stress judgments and the y –axis shows the number of “noun” judgments.

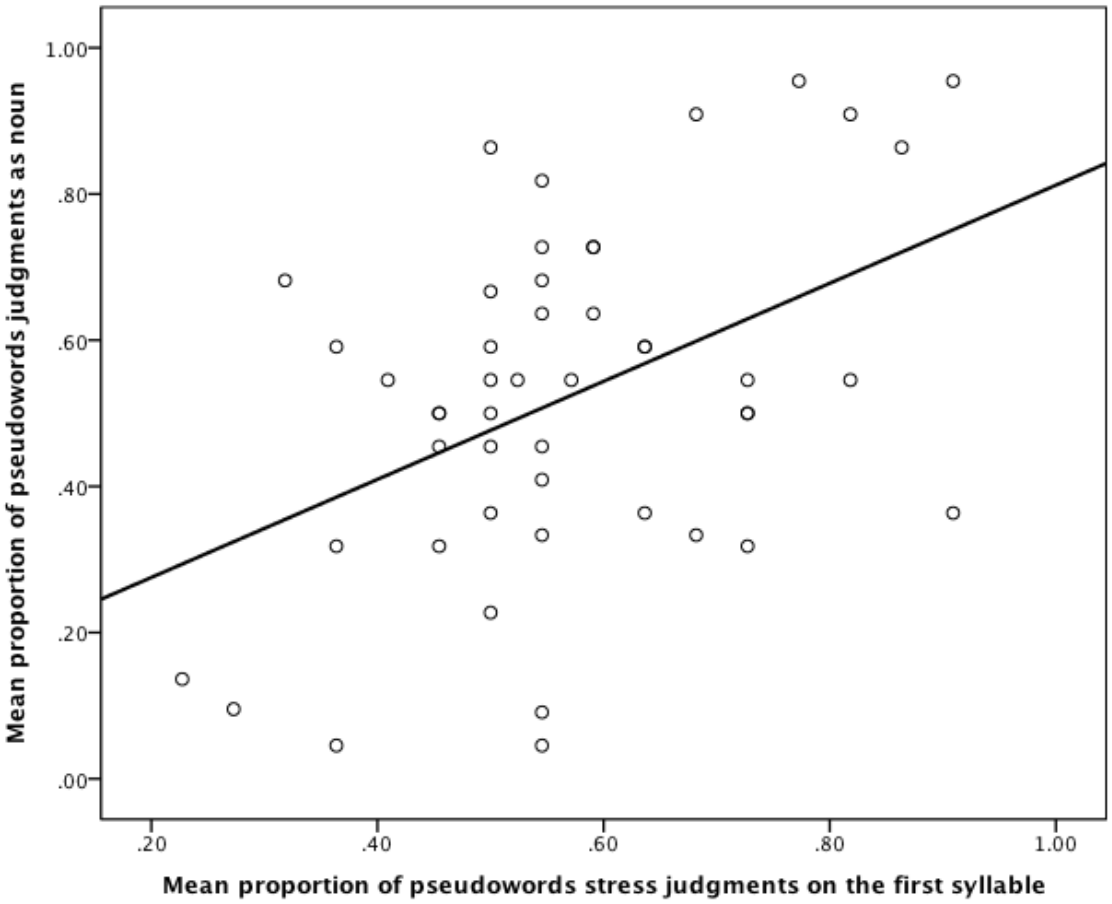

Figure 4: Correlation between “first syllable” choice and “noun” choice: Monolinguals

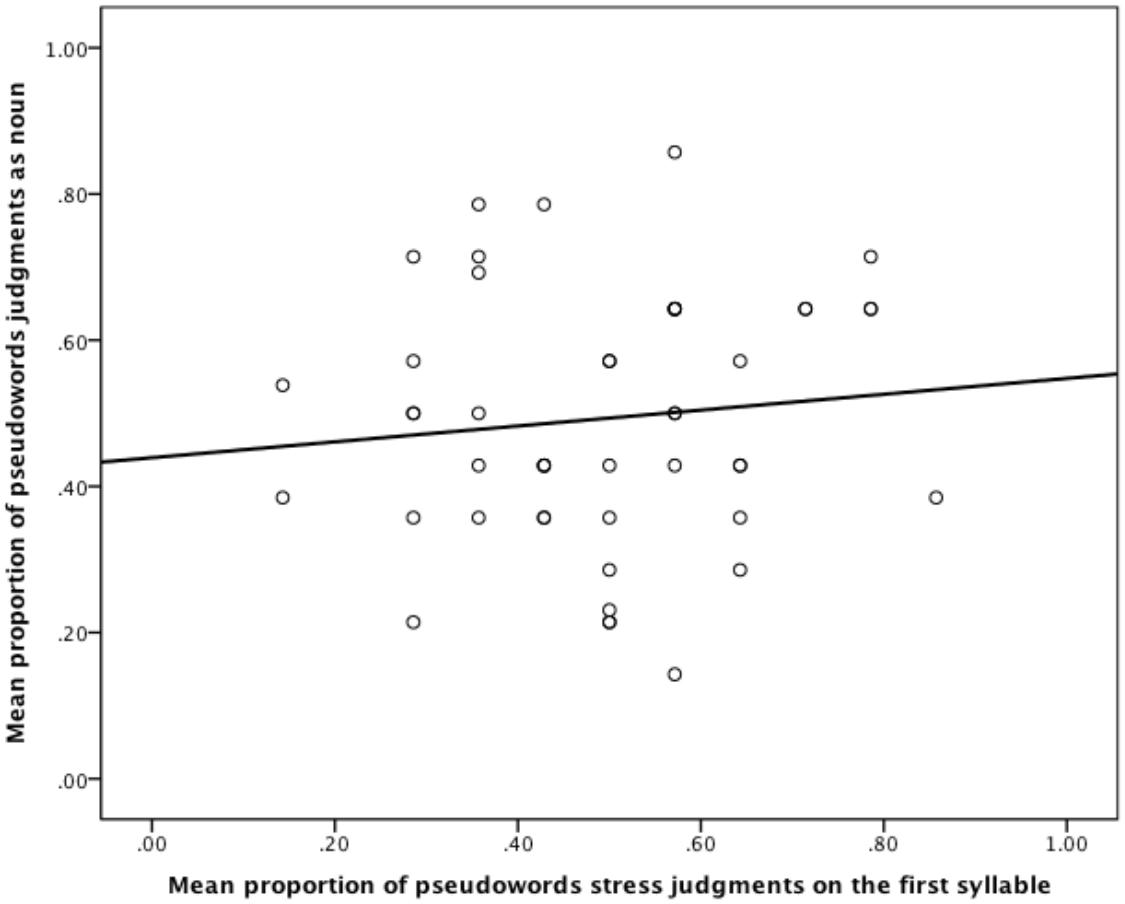

Figure 5- Correlation between “noun” choice and “first syllable” choice: Bilinguals

In Figure 4 (monolingual data), a positive correlation was found, $r(38) = .32$, $p < .01$. This indicates that a noun judgment and first syllable stress is informative for monolinguals, as stress judgment correlated with word classification. In Figure 5 (bilingual data), however, no significant relationship was found, $r\ (46) = .11$, $p > .05$. This demonstrates that there was no relationship between stress judgment and word classification for bilinguals in this study.

Overall Summary of Findings. To facilitate comparison across tasks, a summary of the results of the different analyses is presented in Table 1.

Table 1: Summary of Results Across Tasks (* indicates that the comparison in question was statistically significant at or beyond p<.05)

COMPARISON TYPE	**N/V Classification**	**Confidence**	**Stress**
Monolinguals:			
NL vs VL	*	near sig	*
NL vs C	*	*	not sig
VL vs C	*	*	*
Bilinguals			
NL vs. VL	*	not sig	not sig
NL vs C	not sig	not sig	not sig
VL vs C	*	not sig	not sig

Table 1 (continued)

Noun-like Endings			
Mono vs. Bilinguals	*	*	*
Verb-like Endings			
Mono vs. Bilinguals	not sig	*	not sig
Control Endings			
Mono vs Bilinguals	not sig	not sig	not sig

As may be seen from Table 1, monolinguals showed a strong sensitivity to orthographic cues for syntactic class judgment and their confidence ratings closely paralleled their classification accuracy. Moreover, their stress assignment responses paralleled their word class judgments for nouns vs. verbs and for verbs vs. controls. Stress patterns for control items were the same as those for nouns, suggesting that control endings were given first syllable stress.

Bilinguals also showed sensitivity to orthographic cues for syntactic class judgments. Noun like endings were classified as nouns more often relative to verb-like endings. Verb like endings were classified as verbs more often relative to control endings. As with monolinguals, items with control endings tended to be indistinguishable from nouns in their stress assignment (but – unlike monolinguals - also in their classification). However, bilinguals' confidence ratings did not parallel their classification performance. They were generally less confident about their choices than were monolinguals. Moreover, their stress assignment did not parallel their word classification performance. Thus, use of word endings reliably cues syntactic category and stress assignment only in monolinguals. Bilinguals do not use orthographic cues for their stress assignment choices.

CHAPTER IV

DISCUSSION

Our study was designed in part as a replication of previous work with monolinguals which demonstrated a sensitivity to orthographic cues of word class. Consistent with Kemp et al. (2009), we found that type of word ending significantly influenced participants' judgments of word class: pseudowords ending in noun-like endings were significantly more likely to be assigned to the category of "noun" than those ending in verb-like endings or control endings. Thus, the present study, which used Kemp et al.'s actual stimuli, successfully replicated their findings with a new set of participants. Our study design went beyond that of Kemp et al. in a number of ways: confidence ratings for the word classification judgments were solocited, stress assignment judgments were obtained for the same stimuli as were used for word classification, and performance on word classification and stress assignment was compared in monolinguals and bilinguals.

With respect to individual differences in word classification, we found that word endings reliably cued word class in monolinguals and bilinguals alike. The only observed difference between the groups was a higher incidence of noun selection for noun-like ending stimuli among monolinguals, relative to bilinguals. This indicates that monolinguals may be somewhat more sensitive to the noun-like endings in this task. Aside from this effect, monolinguals and bilinguals were similar in showing an effect of word ending type on word classification.

However, the confidence rating data suggest that the groups' similar performance was not reflected in similar patterns of confidence: monolinguals were significantly more confident about their word classification choices than bilinguals across two of the three word ending types (nouns

and verbs; there was no difference in confidence for control endings). This suggests that even though bilinguals clearly relied on orthographic cues for word class assignment, they were not as confident about their word class judgments as were monolinguals.

Group differences also emerged on the stress assignment task. In this task, it was shown that monolinguals exhibited different stress judgments between the noun-like and verb-like categories, and also in the verb-like category relative to control, but not in the noun-like relative to control category. That is, monolinguals were more likely to select the first syllable as the syllable to be stressed for items ending in noun-like endings, and to select the second syllable as the one to be stressed for items ending in verb-like endings, consistent with the predominant stress patterns characteristic for English nouns and verbs. For the control-ending items, which do not signal word class, the default stress assigned by monolinguals was first syllable, reflecting a noun-bias. For bilinguals, word ending did not reliably cue stress assignment.

There are several possible conclusions to be drawn from the differences observed in the stress judgment task. First, the fact that a dissociation between stress assignment and word class judgment was found at all (in one of our groups) demonstrates that in principle these two processes are separable. That is, there is no necessary co-dependence of one on the other. Alternatively, the lack of correspondence between the two tasks noted for bilinguals may signal that when one knows two languages there may be a loosening of the usual coupling between stress assignment and noun class that is typically characteristic of single language users.

It may also be that monolinguals and bilinguals used different decoding strategies in reading the list of stimuli. It was noted earlier that previous research done on Spanish with Spanish speakers, which constituted the majority of our bilingual group, may not be as sensitive to stress in the absence of diacritic markers. Given the results we have obtained here, this is certainly one

possible explanation. Comments from Guion et al. (2004) also lead one to the conclusion that differences in Spanish prosody could account for these differences. These authors point out that in Spanish the regular rule is for stress to fall on the last syllable of a word that ends in a consonant, and on the penultimate syllable of a word that ends in a vowel. Spanish-English bilinguals in our study, then, may have been using other cues to determine stress information in orthography. It is interesting that a previous study (Kelly & Bock, 1988) did not report any differences between bilinguals and monolinguals on a stress assignment task. However, that task involved auditory presentation of the stimuli. It remains to be seen if the differences we obtained would persist if we had presented the stimuli auditorily and/or asked participants to pronounce the pseudowords rather than having them decide between two visually presented renditions.

The parallel results we obtained in the word classification task to Kemp et. al (2009) are important for a couple of reasons. For one, we included 16 words per ending type instead of the 10 that Kemp et al. (2009) used. This means that our findings are more robust than those previously observed. Second, we have shown that both monolinguals and bilinguals are sensitive to non-morphological orthographic cues for word class. This suggests that non-morphological differences in word ending type play an important role in word recognition as bilinguals picked up on this pattern just as strongly as monolinguals.

There were some limitations of the present study. First, although we found that bilinguals were sensitive to word class based on orthographic cues in pseudowords selected to conform to English, it would be important to demonstrate that they are also sensitive to orthographic cues for Spanish-like pseudowords. Further research should seek to test bilinguals in both their languages. Another limitation of the present research is that the word endings used were screened for English neighborhood size (that is, they did not resemble actual words in English in sound or

spelling). In actual practice, though, speakers make use of analogy in assigning stress to novel words. It would therefore be important in future research to manipulate neighborhood density as an additional cue for stress. Future research should also test the mode of response – e.g., a choice measure, as was used in the present study, versus a production measure, where participants actually produce the pronunciation they prefer. Using such a measure would make the task more natural than asking them to choose a particular written stress pattern.

There are a number of possibilities for further research to build on this study. One, we could extend the monolingual/bilingual observation to the other two tasks Kemp et Al. (2009) examined: sentence construction and sentence judgment. Studies using a more restricted set of auditory stimuli (Kelly & Bock, 1988) did not find differences between bilinguals and monolinguals in these kinds of tasks, so we would be able to see if the orthographic difference observed in this study holds in these other tasks. Another possible extension is to study in more depth the significant noun preference observed in the monolingual group. In both word classification and stress judgment, monolinguals selected nouns in the noun-like category significantly more often than did bilinguals. In future work one could examine if this noun bias is an effect specific to English-speaking monolinguals or to monolinguals per se, in which case it should also hold among other monolingual groups.

This study has brought to light significant differences in the way in which monolinguals and bilinguals use stress to access lexical information. Broadly speaking, these results point towards the primacy of lexical stress in informing monolingual judgments of syntactic categories. These results ought to lead researchers in theoretical linguistics to question why this may be the case, and to provide general principles of the human language capacity which account for these observations. Are there crosslinguistic principles which substantiate what we discovered about

English in this study? These results are significant because past research in generative linguistic theory has considered phonological content somewhat 'blind' to syntactic information. In other words, syntactic information is processed independently of phonetic information, and the two merge, to use the terminology of generative linguistics, only at the end of processing. However, the results provided here directly contradict this view. In fact, we have provided convincing evidence that speakers are aware of deep connections between phonology and syntax, and they generalize these rules in novel words that are possible in English.

Furthermore, we should also question the significance of bilinguals' ability to reliably judge syntactic information but not stress judgment information. This suggests that the syntax-phonology interface may be a part of grammar that is wired during the critical period of language acquisition, and is not something that is easily obtained outside of that period. Another broader question that remains to be answered is how essential the syntax-phonology interface is to grammatical competence. All of the bilinguals in our study were self-rated as fluent, despite the fact that our study demonstrated obvious difference between bilinguals and monolinguals. Our results could indicate significant implications for bilingual processing in the brain. For instance, it may be the case that bilinguals are non-selective in their language processing, meaning that they have all of the languages in which they are competent activated during processing and they use knowledge from all of these languages regardless of which language they are tasked with comprehending. The non-selectivity hypothesis implies that bilinguals area capable of processing more linguistic information than monolinguals, as suggested by the parallel processing of multiple languages. This is an important insight into bilingual processing because it provides knowledge of how the cognitive capacity of the brain may be enhanced by bilingualism, a fact which has been known for some time but which still lacks a sufficient explanation.

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APPENDIX 1

INSTRUCTIONS AND RESPONSE SHEET FOR NOUN/VERB

CLASSIFICATION TASK

Instructions: For this part of the study, we ask that you record whether or not a particular product word sounds more like a noun or a verb. For your reference, we have included examples of nouns and verbs below:

Nouns: Actual word: "I was practicing with my new baseball."

Product word: I walk with my tudeat."

Verbs: Actual word: "John dislikes cold pizza."

Product word: They woreal their documents."

Please classify each product name as ONLY a noun or a verb. Then for each name rate your confidence in your classification on a scale of 1 to 7, with one being the least confident in your choice and 7 the most confident. Also, remember that there is no 'correct' answer. We are trying to get a sense of your personal perception of each word. Remember you should only have 2 boxes chosen for each product word.

	noun	verb	1 ((least confident)	2	3 (	4	5	6	7 (most confident)
barmis (1)	❑	❑	❑	❑	❑	❑	❑	❑	❑
lotact (2)	❑	❑	❑	❑	❑	❑	❑	❑	❑
frinen (3)	❑	❑	❑	❑	❑	❑	❑	❑	❑
sonerge (4)	❑	❑	❑	❑	❑	❑	❑	❑	❑
rintoon (5)	❑	❑	❑	❑	❑	❑	❑	❑	❑

lurdasm (6)	❑	❑	❑	❑	❑	❑	❑	❑	❑
droside (7)	❑	❑	❑	❑	❑	❑	❑	❑	❑
panolve (8)	❑	❑	❑	❑	❑	❑	❑	❑	❑
pretush (9)	❑	❑	❑	❑	❑	❑	❑	❑	❑
sudior (10)	❑	❑	❑	❑	❑	❑	❑	❑	❑
fanold (11)	❑	❑	❑	❑	❑	❑	❑	❑	❑
lorium (12)	❑	❑	❑	❑	❑	❑	❑	❑	❑
asgerve (13)	❑	❑	❑	❑	❑	❑	❑	❑	❑
saneat (14)	❑	❑	❑	❑	❑	❑	❑	❑	❑
prelide (15)	❑	❑	❑	❑	❑	❑	❑	❑	❑
torlasm (16)	❑	❑	❑	❑	❑	❑	❑	❑	❑
welkis (17)	❑	❑	❑	❑	❑	❑	❑	❑	❑
spanen (18)	❑	❑	❑	❑	❑	❑	❑	❑	❑
perold (19)	❑	❑	❑	❑	❑	❑	❑	❑	❑
pitust (20)	❑	❑	❑	❑	❑	❑	❑	❑	❑
lotieve (21)	❑	❑	❑	❑	❑	❑	❑	❑	❑
intoice (22)	❑	❑	❑	❑	❑	❑	❑	❑	❑
trenert (23)	❑	❑	❑	❑	❑	❑	❑	❑	❑
carieve (24)	❑	❑	❑	❑	❑	❑	❑	❑	❑
sartush (25)	❑	❑	❑	❑	❑	❑	❑	❑	❑

asounce (26)	❑	❑	❑	❑	❑	❑	❑	❑	❑
lotium (27)	❑	❑	❑	❑	❑	❑	❑	❑	❑
artaim (28)	❑	❑	❑	❑	❑	❑	❑	❑	❑
tensoon (29)	❑	❑	❑	❑	❑	❑	❑	❑	❑
praten (30)	❑	❑	❑	❑	❑	❑	❑	❑	❑
ramede (31)	❑	❑	❑	❑	❑	❑	❑	❑	❑
mirtasm (32)	❑	❑	❑	❑	❑	❑	❑	❑	❑
tanact (33)	❑	❑	❑	❑	❑	❑	❑	❑	❑
olnoice (34)	❑	❑	❑	❑	❑	❑	❑	❑	❑
gormear (35)	❑	❑	❑	❑	❑	❑	❑	❑	❑
sordate (36)	❑	❑	❑	❑	❑	❑	❑	❑	❑
monust (37)	❑	❑	❑	❑	❑	❑	❑	❑	❑
stinush (38)	❑	❑	❑	❑	❑	❑	❑	❑	❑
telior (39)	❑	❑	❑	❑	❑	❑	❑	❑	❑
lerdear (40)	❑	❑	❑	❑	❑	❑	❑	❑	❑
sanend (41)	❑	❑	❑	❑	❑	❑	❑	❑	❑
arlense (42)	❑	❑	❑	❑	❑	❑	❑	❑	❑
warolve (43)	❑	❑	❑	❑	❑	❑	❑	❑	❑
ursaim (44)	❑	❑	❑	❑	❑	❑	❑	❑	❑
tiseal (45)	❑	❑	❑	❑	❑	❑	❑	❑	❑

ganior (46)	❑	❑	❑	❑	❑	❑	❑	❑	❑
estion (47)	❑	❑	❑	❑	❑	❑	❑	❑	❑
erlaim (48)	❑	❑	❑	❑	❑	❑	❑	❑	❑

APPENDIX 2

INSTRUCTIONS AND RESPONSE SHEET FOR STRESS ASSIGNMENT TASK

Instructions: This task requires you to pronounce each word that you see below.
For each pair, select (circle) the pronunciation that you think is most natural sounding. The capital letters represent stressed syllables and lower case letters indicate the syllable is unstressed. There are no wrong or right answers. We are just interested in your perceptions of how the product names should sound.

Here are some examples of stress representations of actual words:

annoy	anNOY
wonder	WONder

1. Barmis	BARmis	barMIS
2. Lotact	lotACT	LOTact
3. Frinen	FRInen	friNEN
4. Sonerge	sonERGE	SONerge
5. Rintoon	RINtoon	rinTOON
6. Lurdasm	lurDASM	LURdasm
7. Droside	DROside	droSIDE
8. Panolve	panOLVE	PANolve
9. Pretush	PREtush	preTUSH
10. Sudior	sudIOR	SUDior
11. Lorium	lorIUM	LORium
12. Fanold	FANold	fanOLD
13. Saneat	sanEAT	SANeat
14. Prelide	PRElide	preLIDE
15. Asgerve	asGERVE	ASgerve
16. Torlasm	torLASM	TORlasm
17. Welkis	WELkis	welKIS
18. Spanen	spaNEN	SPAnen
19. Pitust	pitUST	PITust
20. Lotieve	LOTIeve	lotiEVE
21. Intoice	inTOICE	INtoice
22. Perold	PERold	perOLD
23. Trenert	TREnet	treNERT
24. Sartush	sarTUSH	SARtush
25. Asounce	asOUNCE	ASounce
26. Lotium	LOtium	loTIUM
27. Carieve	carIEVE	CARieve
28. Artaim	ARTaim	artAIM
29. Praten	praTEN	PRAten
30. Ramede	RAmede	raMEDE
31. Tensoon	tenSOON	TENsoon
32. Mirtasm	MIRTasm	mirtASM

33. Olnoice	olNOICE	OLnoice
34. Tanact	TANact	tanACT
35. Gormear	gorMEAR	GORmear
36. Sordate	SORdate	sorDATE
37. Monust	monUST	MONust
38. Stinush	STINush	stinUSH
39. Telior	teLIOR	TElior
40. Sanend	SANend	sanEND
41. Lerdear	lerDEAR	LERdear
42. Warolve	WARolve	warOVLVE
43. Arlense	arLENSE	ARlense
44. Ursaim	URsaim	urSAIM
45. Tiseal	tiSEAl	TIseal
46. Estion	EStion	esTION
47. Ganior	gaNIOR	GAnior
48. Erlaim	ERlaim	erLAIM

APPENDIX 3

LANGUAGE BACKGROUND AND BROKERING QUESTIONNAIRE

UIN (last 5 digits): _____ Name: _____ Today's date: _____ Email:_____ Sex:____ Age:____ Yr in college ___
What is your first language, i.e. what you first learned to speak first? (If more than one, state all): _____

What other languages do you speak? (If more than one, state all):
_____
When did you learn your other language(s)? ___ 0-4yrs ____ 5-8 _____ 9-12 _____ > 12
What was/is the main language of instruction in your:
a. Elementary School _____
b. Middle School _____
c. High School _____
d. College _____
How do you define yourself in terms of ethnic or cultural identity to others outside your ethnic group? (Please circle)

1. Mexican
2. Mexican American
3. Latino/a
4. Hispanic
5. Puerto Rican
6. Cuban American
7. Chicano/a
8. American
9. Other (please specify) _____

In your high school, about what percentage of students were the same ethnicity as you? (Please circle)

1. less than 10%
2. around 25%
3. around a third
4. 50%
5. 75%

Compared to when you were a child, how has your view of your ethnic or cultural identity changed?

1. I am more __ or less__ (choose one) conscious of my ethnic identity now than as a child.
   __ No change in awareness

2. I am more___ or___ less (choose one) proud of my ethnic identity now than as a child.
   ___ No change in attitude

Please select one as appropriate:

1. I keep my heritage culture **separated** from ____ or **integrated** with ____ the culture of the majority community.
2. I am **comfortable** ____ or **uncomfortable** ____ moving between two cultures.
3. I identify culturally most strongly with _____ (fill in).

Use the scale below to answer to indicate how much you enjoy (Please circle):

Never	**Rarely**	**Sometimes**	**Often**	**Always**
1	**2**	**3**	**4**	**5**

1.Listening to music in Spanish	1	2	3	4	5
2. Watching TV programs or movies in Spanish	1	2	3	4	5
3. Eating food from your heritage culture	1	2	3	4	5
4. Travelling to Spanish-speaking countries	1	2	3	4	5
5.Listening to music in English	1	2	3	4	5
6. Watching TV shows or movies in English	1	2	3	4	5
7. Eating all American food	1	2	3	4	5
8. Travelling and visiting in the US	1	2	3	4	5

Please rate your language ability in English and Spanish on a 7 point scale where **1=very little knowledge and 7=use it like a native speaker:**

Very little knowledge						**Like a native speaker**
1	**2**	**3**	**4**	**5**	**6**	**7**

Speak English	1	2	3	4	5	6	7
Read English	1	2	3	4	5	6	7
Write English	1	2	3	4	5	6	7
Understand English	1	2	3	4	5	6	7
Speak Spanish	1	2	3	4	5	6	7
Read Spanish	1	2	3	4	5	6	7
Write Spanish	1	2	3	4	5	6	7
Understand Spanish	1	2	3	4	5	6	7

What language(s) do you **mostly use** when speaking with each of the following (Please circle):

	English	Spanish	Both	Other
a. Mother	1	2	3	4
b.Father	1	2	3	4
c.Siblings	1	2	3	4

d.Grandparents	1	2	3	4
e.Friends	1	2	3	4
f.Classmates	1	2	3	4
g.Co-workers	1	2	3	4
h.romantic partner	1	2	3	4
i.Other (specify)	1	2	3	4

In which language(s) do you/would you **typically** do each of the following activities (Please circle)::

	English	Spanish	Both	Other
a.Express affection	1	2	3	4
b.Express anger	1	2	3	4
c.Pray	1	2	3	4
d.Dream	1	2	3	4
e.Think to yourself	1	2	3	4
f.Mentally add, multiply	1	2	3	4
g.Tell jokes or funny stories	1	2	3	4
h.Keep a diary	1	2	3	4

APPENDIX 4

LIST OF WORDS BY ENDING TYPE IN KEMP ET. AL (2009)

Noun-like Words	Verb-like words	Control words
barmis	lotact	frinen
rintoon	sonerge	droside
lurdasm	panolve	fanold
pretush	asgerve	saneat
sudior	lotieve	prelide
lorium	intoice	spanen
torlasm	carieve	perold
welkis	asounce	pitust
sartush	artaim	trenert
lotium	ramede	praten
tensoo	tanact	gormear
mirtasm	olnoice	sordate
stinush	sanend	monust

telior	warolve	lerdear
ganior	ursaim	arlense
estion	erlaim	tiseal